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OFFICE OF FOREST PATHOLOGY

San Francisco Branch
In cooperation with U.S.Forest Service

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WITH SPECIAL REFERENCE TO DISEASE HAZARDS

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CORK OAK IN CALIFORNIA,
WITH SPECIAL REFERENCE TO DISEASE HAZARDS

Among the important products used in large quantities in the United States, for which current war conditions have seriously limited the supply, is cork. This commodity, obtained from the bark of the cork oak, Quercus suber, is produced principally in Portugal, Spain and parts of North Africa. Smaller quantities are grown in southern France and other sections around the Mediterranean.

The present shortage, a repetition of the one suffered in World War I because of the reduction in available ocean transport, has given new impetus to interest in the possibilities of establishing domestic sources for supplies of corkwood to supplement foreign ones, not only to tide over possible future emergencies which might entail shortages of foreign cork, but to provide the basis for a modest domestic cork industry built around local sources of supply.

The idea is not new in California. As pointed out by Extension Forester Woodbridge Metcalf[1/], in a report prepared for the Sacramento Region Citizens Council in 1929, it was early recognized that portions of the State offered climatic and site conditions very similar to those of the Mediterranean region where the tree is native, and scattered plantings were made many years ago. The Federal Government (Commissioner of Patents) imported acorns as early as 1854 and during the 70s the United States Department of Agriculture is reported to have introduced a quantity of cork oak acorns and to have given them rather wide distribution to farmers. In subsequent years the Department introduced many more lots of cork oak acorns and distributed them as seeds or plants through the Chico Plant Introduction Garden. The College of Agriculture of the University of California under former Director E. W. Hilgard likewise distributed acorns to a considerable number of farmers, and various private nurserymen have at one time or another produced and sold cork oak nursery stock. Over the years many private individuals have also become interested in the growing of cork oaks in the State and have either imported seed or have planted that already available from local sources.

Most of the plantings were in small lots of a few trees each but, according to Metcalf in the report previously cited, several attempts to establish plantations were made. In one of these, at the old Chico Forestry Station, now a part of Bidwell Park in Chico, California, fairly good survival was obtained and the resulting grove numbers approximately 400 trees. The United States Forest Service

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1/ Metcalf, Woodbridge. Cork oak - a forest tree with possibilities for California. Monthly Bulletin, Dept. Agr. State of Calif. 18 (10): 539-561 October 1929.

made several attempts to establish plantings between 1910 and 1915 on what are now the Los Padres and Angeles National Forests, without success. A planting was also tried on the grounds of the former Santa Monica Forestry Station in southern California but the trees failed to become established.

From these combined past efforts, plus plantings for ornamental or shade purposes, it is estimated that something over 2,000 cork oaks are now growing in California and it is possible that this figure may require upward revision when information regarding scattered specimens becomes more complete.

The recent revival of interest in cork oaks in California is apparently traceable to the interest of Mr. C. E. McManus of the Crown Cork and Seal Corporation, Baltimore, Maryland and to the Extension Forester for California, Mr. Woodbridge Metcalf. With Mr. McManus's support, and the active participation of the Extension Forester's office and Mr. G. D. Greenan of San Francisco something over 5 tons of cork was harvested during the summer of 1940, principally from 3 plantings in northern California and was shipped to Baltimore for testing, where it was pronounced equal in every way to imported cork of the same grade.[2/] Additional stripping was undertaken, mostly in southern California, in 1941. This winter, with the support of Mr. McManus and the cooperation of the State Division of Forestry, about 17,000 cork oak seedlings have been distributed through the Extension Forester for planting.[3/]

Prospects for Cork-growing

While our Division is mainly concerned with the disease and related hazards pertaining to cork oaks it has seemed worth while to explore to some degree the prospects for the success of cork production in the United States from other aspects, since disease handicaps would be of no particular import if there were other factors which independently would operate to prevent cork production on a successful industry basis. In this exploration the background material and observations of former Principal Pathologist E. P. Meinecke, gathered in the course of his European experience, have been exceedingly helpful. Other very helpful sources of information have been the Forestry Notes series of the Extension Forester for California, a recent publication by Faubel[4/] and verbal information from several local representatives

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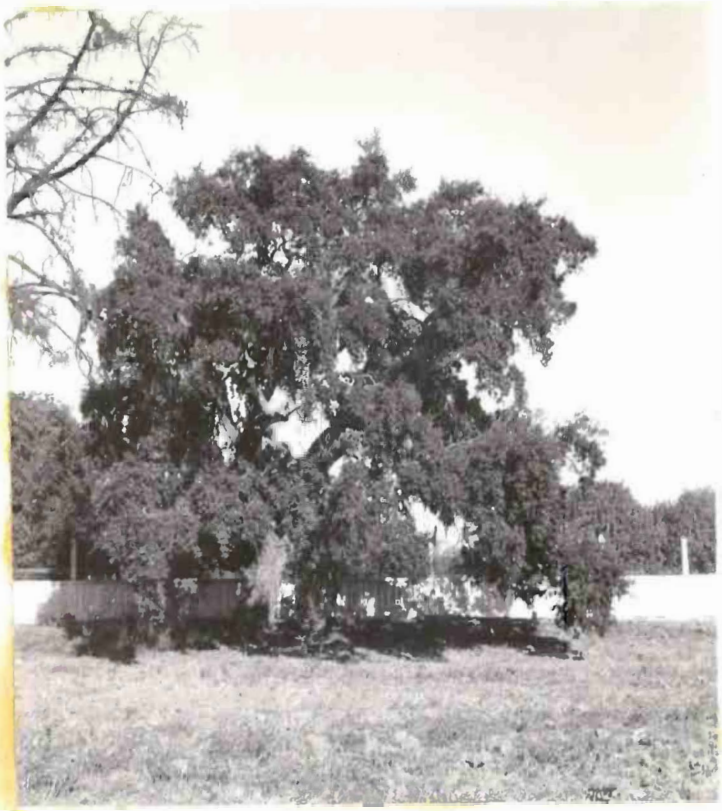
2/ Cooke, Giles B. Cork from California. News Edition, Am. Chem. Soc. 19:256-258 Mar. 10, 1941.

3/ Metcalf, Woodbridge. Forestry Notes - November-December 1941. 3 p. Extension Service, Univ. of California, 1942.

4/ Faubel, Arthur L. Cork and the American Cork Industry. Rev. Ed. p. 151. Cork Inst. America New York 1941.



Cork oak near Agnew, California,
about 80 years old.

Cork oaks in Bidwell Park, Chico, California,
one year after peeling.

of the cork industry, in particular Mr. C. D. Greenan of the Western Stopper Company.

Future of cork

Many natural products formerly in demand have been crowded out of the market by their synthetic counterparts or by substitute materials. In the case of cork from the cork oak there is the question both of a possible development of this sort and of the possible replacement of oak cork by cork from other plant sources such as from certain conifers or from the Brazilian cork tree, Kielmeyera coriacea.

I found the opinion general among men conversant with the industrial uses of cork that as long as it remained obtainable in the future at a reasonable figure they could foresee no general displacement of cork by substitute materials because of certain natural advantages offered by it over its substitutes, though for practically every use to which cork is now put there are substitutes already available. Approximately 60 percent of the normal cork importations into the United States now go into insulation and only about 10 percent into corks, stoppers and into liners for crown bottle caps. The balance is absorbed in such miscellaneous products as life preservers, fish net floats, gaskets and linoleum. As an insulating medium cork is particularly valuable where condensation is likely to be a factor, as in cold storage installations.

Other natural sources of cork seem to offer little prospect of supplanting that from the cork oak, either because of harvesting costs or on account of limited supply, except to some local degree. About 8,000 tons per annum of cork from the Brazilian cork tree are harvested in that country but supply only local demands for insulation within Brazil itself.5/ As an export material it could hardly compete with oak cork and shows no promise of large exploitation in Brazil.

Certain western conifers, such as the cork-bark fir, Abies arizonica, and the intermountain form of douglas fir, produce thin layers of cork that has been under investigation by the Forest Service as a substitute for oak cork for certain purposes but harvesting problems would appear to make its utility dubious even if technical qualities are found to be satisfactory.

Size and nature of plantings

It seems extremely doubtful whether the United States should ever attempt to supply all its normal cork requirements even though, with subsidization, this could probably eventually be done. Under normal circumstances the United States provides the chief world market for cork. Its harvesting and handling affords a meagre livelihood for

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5/ Butterick, P. L. Note on Brazilian cork. Tropical Woods No. 68: 11-13. Dec. 1, 1941.

peasants and workers in countries of origin that are poor in other natural resources, so that a severe curtailment of outlets for cork would bring with it serious problems of existence for these people. Moreover, the United States could probably not economically meet all of its own needs for cork because of higher initial costs of production and transportation costs to many of the principal centers of consumption.

On the other hand, unless domestic plantings were of sufficient extent to support a local industry of at least moderate proportions, they would be relatively valueless as a source of supply in times of emergency, not only from the standpoint of available volume but because of the lack of opportunity to organize harvesting, handling and manufacture on an industry basis. Cork must be harvested at periodic intervals if it is to be of high quality. The initial crop of cork from a tree, termed "virgin cork", is almost invariably of low grade, suitable only for use in granular or powdered form. It is not until about the third harvesting that high quality grades are obtained.

For California and Arizona, the only western states outside of possibly a restricted area in southern Oregon where climatic conditions suitable for the growth of cork oaks are to be found, a logical program would appear to consist in the development of plantings calculated, under conservative normal harvesting practices, to supply the cork requirements of that portion of the United States lying west of the Rocky Mountains where the product would have the maximum advantage in competing with foreign supplies because of the higher transportation costs to the West as compared with the Eastern part of the United States. There might also be provided a moderate reserve of trees on which the cork would not be harvested regularly but which could be stripped to supply a low grade product in times of emergency.

Cork consumption on the Pacific Coast is estimated at about 15,000 tons annually out of a total national consumption of about 115,000 tons and the demand is sufficiently diversified to provide a market for practically all grades, including cork waste. Counting on the basis of an average annual yield of 200 lbs. per acre and a stocking of 200 trees per acre, some 30 million trees or 150,000 acres would be needed to furnish this amount. Provision for a reserve for national emergencies would add perhaps another 10 million trees, making about 40 million that would be needed in all to provide a supply that would have any real significance from the local and national standpoint. In connection with the figure for emergency reserves it is anticipated that peeling from trees normally harvested for western requirements could be greatly accelerated in case of need and that some reserve stocks of foreign cork would be on hand. The supplies from these sources could be augmented by corkwood from roadside trees or reserve plantings not worked on a regular production schedule. This corkwood, while of low grade, would be usable for certain purposes, particularly when better grades were not available in sufficient quantity, and would aid in overcoming an emergency shortage of foreign supplies.

At present there are no cork processing plants on the Pacific Coast but there is definite assurance from industrial sources that such plants would be established if an adequate local source of corkwood to supply them were developed. Most of the cork normally used in the West is shipped to factories on the Atlantic seaboard, processed there and reshipped in manufactured form to the West coast. Some items, such as net floats, are at times imported directly from Spain, Portugal or Algeria.

Among the chief reasons why past interest in cork oak in California has not resulted in development on a commercial scale have probably been the relatively low rate of return that could be anticipated at prevailing price levels for cork and the length of time that would be required before the trees became large enough to strip of a salable product. Because of these considerations the most promising current line of approach in interesting private owners in planting the species has appeared to be in promoting the planting of roadsides, unused corners and ground unsuited for other crops in districts suitable for the growth of the tree, with the idea that such plantings would be supplementary to regular farming operations or sources of income and not major cultural operations in themselves.

Private planting of this or other types should be encouraged and furthered to the fullest extent but there seem to be grounds for skepticism whether such a program is likely, in itself, to provide the necessary acreage to achieve the desired purposes even with a strong promotional effort. The prospect is that private plantings will need to be augmented on a fairly large scale and public agencies, utilizing low-value tax-free lands not now yielding any appreciable revenue, appear to be in the best position to do this. Cork oak groves or forests established by a public agency would be more amenable to management on a planned, coordinated basis and, through the opportunity for concentration in large acreage blocks, would be valuable as producing centers around which a harvesting and marketing industry might be developed. Moreover a public agency would be in a much better position than the average private owner to plant in the public interest and to carry developmental costs on cork oak forests managed primarily for emergency reserve purposes.

In California parts of several National Forests, and particularly the Los Padres, covering much of the hilly and mountainous country of the southern Coast Ranges offer climatic and environmental conditions very similar to those of regions to which the cork oak is native, except probably for average length of the summer dry period, and would appear to be well adapted for woodlands of this species if the problem of initial establishment can be solved.

Moreover, a cork oak planting project would appear to meet very satisfactorily the requirements for high priority as a post-war activity to provide jobs during the anticipated readjustment period while the nation is changing from a war to a peace-time basis, though a real obstacle might prove to be the obtaining of acorns to provide the necessary planting stock.

Other considerations

One item that in the past has weighed heavily against prospects for profitable cork production in this country has been the labor required in the harvesting processes of peeling the bark, boiling and scraping it and concentrating the peeled corkwood for shipment. Hand peeling with the tools commonly in use in Europe is a relatively slow operation, the man-day accomplishment varying widely according to the age and character of the trees and their distance from one another. At American wage levels, even for agricultural workers, producers here would have difficulty in competing with foreign labor in the harvesting operations if foreign methods were followed. However, through the development of new tools for stripping and other modifications in the harvesting procedure there is good reason for expecting that the per-man output here could be very materially increased over the European average, thus tending to overcome the wage differential to be anticipated between operations here and in Europe.

The cork oak is a tree that does not thrive under crowded conditions and ample space needs to be provided between trees in the setting out of plantations. Accordingly a cork oak woodland allows some growth of forage so that the use of the land for grazing after the cork oaks have become established is not wholly precluded. In Europe a common practice is to run hogs in the cork oak stands, the animals utilizing the acorn crop for feed. Hog production thus supplements cork production as a source of income and when the trees become too old for growing cork they yield charcoal and tannin. In California the areas most suitable for cork oak are grazed principally by cattle. Grazing use would probably have to be discontinued while the trees were becoming established but should afterward be resumed as one means of reducing the fire hazard. Present income from these lands from grazing would thus be interrupted for a time and in the future would suffer some reduction if cork oak plantations were successfully established but should not be completely eliminated.

Disease and Other Hazards

Fungus Diseases

A survey of a number of cork oak plantings in the northern part of California has produced no indications of any fungus diseases likely to be of serious consequence in the growing of this species. Among the trees on the McGill ranch near Oakville in Napa County one, near a ditch dry most of the year, showed considerable die-back in the top. In the absence of any evidence of a twig pathogen this may have been due to fire scorching at some previous period as a large fire scar was present on the side of the trunk. Excess soil moisture during the rainy season was also considered as a possible cause for the die-back. Two other trees on hillside sites were noted with thin crowns, the cause of which was not determined but did not appear to be from any twig disease. In both instances adjoining cork oaks were in

good condition. Gopher injury to the roots was a possibility in connection with these trees which was not investigated.

Near Agnew, Santa Clara County, two old trees of an original row of seven collapsed about 10 years ago as a result of combined root and heart rot. Three had previously been lost from unknown causes. Site conditions, such as changes in water level and abuses such as soil compaction and wounding arising from the former close proximity of workmen's dwellings, were undoubtedly contributing factors in the decay of these trees. No evidence has yet been obtained on whether cork oak is susceptible to the California strain of the so-called oak root fungus, Armillaria mellea, which is almost invariably associated with the native oaks in woodlands occupied by these species but to which they are relatively resistant except when handicapped by unfavorable changes in site conditions or in a general state of decline from old age. The question of the susceptibility of cork oak to attack by Armillaria undoubtedly deserves further exploration since plantations would be likely to be made on ground now occupied to some degree by native oaks.

Metcalf, in the report previously cited, records the occurrence of the oak mildew, Sphaerotheca lanestris, which forms witches'-brooms on affected trees. This mildew is quite common on live-oaks, particularly in the coastal region of California, but occurs mainly where succulent new growth has been forced out by heavy pruning or very favorable growth conditions. It practically never kills trees and seldom interferes seriously with their growth unless they have been heavily pruned back or abnormal growth has been forced by over-fertilization. The disease should not be serious in cork oak plantations.

Meinecke[6/] reports heavy losses in Spain from fungous and insect damage to cork. A rot of the cork is common where the trees grow in dense stands or where the trunks are smothered by thick undergrowth but does not occur when the boles receive sufficient light and air. Means of avoidance of the loss therefore seem obvious. Fungous deterioration also results from careless storage of the harvested cork in the open. It is customary in Spain to leave cork in storage piles in the open during part or almost all of the rainy season. Piles are made directly on the ground and without any attempt at shaping them to form a natural roof. At the factory the cork may undergo additional months of open storage after it is baled, likewise directly on the ground and without any form of roof protection. Practically all the deterioration initiated during the storage period is avoidable through relatively simple precautions in the manner of storage or in the handling schedule and thus need not be a factor in cork production in this country.

6/ Meinecke, E. P. Notes on cork oak in Europe and its possible cultivation in the United States. Unpublished memorandum, Division of Forest Pathology, Dec. 10, 1929. Also field notes.

Other Injuries

In a plantation near Chico considerable limb breakage of cork oaks was occasioned a few years ago by wet snow. Snow occurs only rarely at Chico and in most other areas within safe temperature limits where the planting of cork oaks might be contemplated the danger from snow breakage would be minimal and could be disregarded as a hasard in cork production.

One trouble which has been of some consequence in Europe and North Africa and would need to be guarded against here is a drying and death of the inner bark of the tree following peeling. It is most likely to occur when peeling is carried on during hot, windy weather or when trees are on very dry sites. It can be avoided by discontinuing the peeling operation during extremely hot, dry spells or confining it during such weather to vigorously growing trees on rather moist sites.

Insects

So far as known the question of probable insect hasard to cork oaks in California has not been investigated by the entomologists. A gall wasp, Plagiotrochus suberi, is reported to have become established in southern California and to have rendered attacked trees there very unsightly.7/ In Europe the tree has a number of insect pests8/ which damage the cork or otherwise affect cork production. Before planting is undertaken on a large scale in California an appraisal of possible insect hasard would appear to be desirable.

Rodents

According to Medrano and Ugarte, cited above, field mice and rats are the only rodents of any consequence affecting the growing of cork oak in Spain. In California, preliminary indications are that the pocket gopher is probably the chief rodent to be reckoned with, because of his apparent liking for cork oak roots, though ground squirrels will readily take acorns if directly planted out and may also destroy very young seedlings to which the acorn is still attached. From what is known of losses already sustained in experimental plantings it is apparent that rodent control will be a necessary antecedent to the planting of cork oaks where these animals are present in any significant numbers.

Frost

Cork oak is typically a tree of warm or mild climates and is

7/ Quoted in Forestry Notes. November-December 1941 by Extension Forester from report "Cork Oak in Los Angeles County" prepared by Los Angeles County Forestry Department.

8/ Medrano, Luis Velas de and Ugarte, Jesús. El alcornoque y el corcho. pp. 236 Calpe, Madrid 1922.

likely to be endangered by temperatures below 15°F. From the standpoint of cold damage the critical period for trees peeled for cork is the first winter following the peeling operation, before the new cork layer has had time to gain appreciable thickness. In the selection of districts for the planting of cork oaks for cork production it is therefore necessary to take into account the lowest minimum temperatures likely to be reached over a period of years rather than the average annual minimum. This necessity restricts the safe range to relatively low elevations and to parts of the country where minimum temperatures do not fall lower than 10-12°F., though cork oaks can often be made to grow in districts where minimums below this occur only occasionally. For example in the warmer portions of South Carolina a number of good sized cork oaks occur and are doing well according to information from Senior Pathologist G. F. Gravatt of our Washington office but because absolute minimum temperatures occasionally reach almost zero in that territory it would appear unwise to attempt to develop commercial plantings there and run the risk of future loss of peeled trees in the infrequent cold waves when temperatures approach zero.

Fire

The cork oak is by nature well protected from serious damage by fire because of the high insulating quality of the bark and the character of its leaves but after stripping it is quite susceptible to fire injury. Moreover fires damage the cork even if the latter is thick enough to protect the trunk which it covers. For these reasons precautions against fire must be taken. In the selection of planting sites the relative fire hazard should be given strong consideration and if it appears that effective fire preventive measures can not be practically applied on areas of normally high hazard these should be avoided in the planting program. The removal of underbrush and vines from around the trees which is a desirable practice for other reasons as has already been indicated, will assist in the prevention of fire damage.

Soil and Moisture Requirements

European experience has demonstrated that the cork oak does not do well on lime or heavy clay soils and that the site must be well drained. In its native range it is more often found on hill slopes than on level land though it appears to do satisfactorily on level ground providing the drainage is good and the soil is not too heavy. Site definitely influences cork quality, but in an inverse ratio, the better sites for growth of the trees producing the poorer grades of cork.

The moisture requirements of the tree have probably been somewhat misjudged in the attempts to establish it in California. While the regions where it grows in Europe are characterized by a climate with distinct wet and dry phases as is also the south Pacific Coast in this country the rainfall in the European habitats is more evenly distributed over the year than in California as will be evident from the following comparisons:-

Precipitation, Average Annual and Average June-September. 9/

Mediterranean	Ann.	June-Sept.	Californian	Ann.	June-Sept.
Lisbon, Port.	28.87	2.99	Ukiah	35.46	.85
Seville, Spain	18.55	1.50	St. Helena	31.90	.75
Algiers, Algeria	27.43	2.16	Paso Robles	16.39	.35
			Priest Valley	19.82	.35
			Ojai	21.61	.39
			Sonora	32.16	.74
			Placerville	38.54	1.29
			Auburn	32.64	.85

While the foreign stations shown are not in the cork oak woodlands they are cork marketing centers reasonably close to the cork oak zones and with the same general pattern of precipitation. In general, rainfall will be somewhat higher in the hill country where the cork oaks occur.

It will be noted that while the annual precipitation for the Californian stations compares with or exceeds that for the Mediterranean stations the total for June to September inclusive is much lower in proportion in California than at the foreign stations. In the Mediterranean regions appreciable amounts of rain normally fall in both June and September though occasionally the initiation of fall rains may be delayed until October. In California, rains between June 1 and October 1 in sufficient amount to provide more than a surface wetting of the soil occur only in occasional years at elevations suitable for cork oak and a dry period of 4 months' duration must ordinarily be counted on.

Like many other oaks the cork oak tends to be deep-rooted and so will undoubtedly survive satisfactorily without irrigation in parts of California now or formerly supporting native oak woodlands. This is indicated by the cork oaks already growing in the State. The long period of summer drought is likely to be a serious handicap to the establishment of plantings, however, and it may be that supplemental watering will be necessary in most situations for the first year or two until the trees become established. It is probable also that on account of the difficulty of establishment, care will be needed in the selection of planting sites and that in many parts of the State that would be otherwise suitable, planting will have to be avoided except on very favorable sites. Areas close enough to the coast to receive some benefit from the lowered temperatures and higher humidities imparted by the coastal marine air, and at the same time far enough inland to be protected from direct ocean winds and fogs, would appear to offer the best prospects as potential planting sites.

9/ Reed, Wesley W. The climates of the world. Yearbook of Agriculture, U. S. Dept. Agr. 1941:665-684 1941.

Causes of Past Planting Failures

From the information reported by Extension Forester Metcalf it is evident that while several factors, such as poor condition of the planting stock, destruction by gophers or other rodents and unsuitable planting sites have no doubt contributed to the failure of a number of the plantings that have been attempted in California the chief cause of failure has unquestionably been a lack of sufficient moisture for the establishment of the seedlings. At least two of the plantings attempted by the Forest Service were followed by summers of more than normal dryness but even in the plantings made in years when precipitation was normal or above the survival was either poor or nominal, in spite of good ground preparation before planting and subsequent care in keeping down weeds.

In this connection it may be pointed out that establishment of new seedlings of the coast live oak and valley oak, which occur in scattering open woodland formations over much of the territory where cork oak might be expected to do well, takes place very infrequently. These species are probably better adapted to survival in our summer dry periods than the cork oak but if attempts were made to establish plantations of them without supplemental irrigation most of these attempts would be likely to fail except in especially favorable years. If our own native oaks find difficulty in establishment we should not anticipate any less difficulty from a species native to regions with a dry season less prolonged than ours.

It seems evident that if planting of cork oak is to succeed on any adequate scale here, planting sites will need to be carefully chosen and more than simply planting the trees will be required to bring them through the first two or three years until they have become well established. What the minimum additional necessary measures to assure reasonable success will be is a question that will require careful study and trial for determination, as near as can be judged from results of planting attempts to date.

Opportunities for Improvement of Stock

Cork oaks exhibit a wide variability, not only in such features as the size and shape of the acorn, but also in quality of corkwood yielded, thickness of the cork layer, ease of stripping and other characters influencing their value as cork producers. Most cork from abroad comes from natural stands where no selection has been practised and it is questionable whether selection has played much part in plantations that have been made there.

Unquestionably the species offers a most promising opportunity for improvement through selection and breeding for cork production and, to the extent that it can be made available, stock of superior potentialities should be used in the establishment of plantations. For the immediate future the opportunities for doing this appear limited if selection and controlled pollination must be confined to trees growing

in this country, because of the small amount of acorns that could be made available from superior trees that are likely to occur here. If selection could be extended to the Mediterranean countries and acorns from the selected trees could be obtained the potential acreage of high quality stock might be greatly increased but the prospects for being able to do this are not good. It is natural that the present cork producing countries would not look with favor on providing acorns that might lead to a loss of markets for them. It may be added that grafting is not a successful method of propagation of the cork oak and would offer no prospects as a means of multiplying superior strains of the tree.10/

Outlook

In his report for the year 1854 the United States Commissioner of Patents, commenting on the introduction of cork oak acorns, spoke hopefully of the day when "the increasing wants of the country for cork may fully be met by the home supply" and offered the opinion that "if the introduction should prove successful, the enterprise cannot be regarded otherwise than of national importance." Today, almost nine decades later, the country is scarcely nearer to supplying any part of its wants for cork than it was in 1854, despite introduction after introduction of acorns and the expenditure of considerable aggregate effort in experimental plantings. Something has been accomplished in demonstrating that, once established, the cork oak will grow satisfactorily in certain parts of the country but this could have been predicted with confidence by any competent ecologist. Something has also been gained in experience from planting attempts but these have not yielded the body of reliable basic data needed before large scale operations are undertaken.

A realistic consideration of the question of possibilities of cork production in California seems to the writer to warrant the following conclusions:

1. Cork oaks must be established on a sufficiently large scale to provide the supply for a future cork industry on the Pacific Coast; otherwise there is no point in attempting to plant them at all other than as ornamentals, unless it might be to provide a wider basis for selection for improved planting stock for some possible future planting program.

2. To obtain this large scale establishment the efforts of small private owners must be augmented by those either of a public agency or of a private corporate agency with ample finances.

3. A planting program cannot succeed as a side issue, either under public or private auspices. If it is to be a success it must be undertaken seriously as a full-time job, with adequate backing.

10/ Medrano and Ugarte Op. cit.

4. In California the biggest, but by no means the only problem to be solved will be to secure initial establishment of the trees. Unless means of doing this at a reasonable cost on low-value hill lands can be worked out there can be no hope for a cork industry in the State. Site selection will play an important part, both in the chances for survival of the young trees and in the quality and quantity of cork produced if survival is obtained.

5. Until such time as conditions justify an expansion, the aim of planting in the West should be to supply the normal Pacific Coast market for cork, where the product will have maximum advantage in transportation costs. Under emergency conditions production could be stepped up to supply essential national needs.

6. There are good prospects that much of the disadvantage of higher labor costs here as compared with present producing areas could be overcome by the development of improved tools for harvesting and improved handling methods.

7. On the basis of present indications there are no diseases or pests of cork oak in California that would seriously interfere with the growth of the tree or with cork production. Further studies of possibilities along these lines are needed, however.

8. Cork oak appears to offer excellent opportunities for the development through selection and breeding of superior strains of stock especially adapted to cork production.